Syllabus of STAT 648

Graphical Models and Networks

Prerequisites: either STAT 431 or approval of instructor

Meeting dates, times, and places

Dates: Tuesday, Thursday, January 14—April 24 with the exception of

— Thursday, February 20

— Tuesday, March 4: Spring break

— Thursday, March 6: Spring break

— Thursday, April 3: Midterm recess

Times: 1:00—2:15

Places: Keck Hall 107

Other important dates are listed on the website of the Office of the Registrar.

Instructor

Name: Dr. Michael Schweinberger

Office: Duncan Hall 2058

Office hours: By appointment

Email: michael.schweinberger@rice.edu

Course objective

Graphical models—aka Bayes networks, Markov networks, Gaussian networks, etc.—have been widely used to represent complex phenomena with dependence. The course aims to

- stimulate interest in graphical models.
- be a window into the world of graphical models.
- be a stepping stone with a view to doing research involving graphical models.

Course contents

One or more of the following books is recommended, but not required:

- Lauritzen (1996).
- Cowell, Dawid, Lauritzen, and Spiegelhalter (2003).
- Wainwright and Jordan (2008).
- Koski and Noble (2009).
- Koller and Friedman (2009).
- Other books which will be circulated in class on Tuesday, January 14.

We follow Lauritzen (1996), Chapters 1–3 and selected sections of Chapters 5 and 7, as well as additional books and book chapters. Topics include, but are not limited to:

- Graphical models: graphs representing conditional independence relations among random variables:
  - Markov properties.
  - Undirected graphical models (Markov networks).
  - Directed graphical models (Bayes networks).
  - Gaussian graphical models.
  - Exponential-family representations of graphical models.
- Statistical inference:
  - Structure of graphs.
  - Parameters given structure of graphs.
- Properties of statistical methods:
  - Asymptotics based on more and more independent graphs of fixed size.
  - Asymptotics based on more and more independent graphs of increasing size (high-dimensional data).
  - Increasing-domain asymptotics based on one graph of increasing size (spatial data, network data).
- Applications:
  - Gaussian graphical models.
  - Genetic networks.
  - Biological networks.

  - Spatial data.
  - Network data.
  - Other applications may be considered upon request.

Grades

- Homeworks: 30%
- Midterm: 30%
- Final project: 40%
- Bonus: participation: 5%

Homeworks must be submitted at the beginning of the class on the due date. Late homeworks will be accepted, but the grades of late homeworks are discounted by factor 0.5 every 12 hours. There are no exceptions. The lowest homework grade will be dropped.

The midterm exam will take place on March 20. The midterm exam will be open-book and in-class.

The final project is either an original research project, a survey of literature on a selected topic, or participation in a competition.

Disabilities

If you have a documented disability that will impact your work in class, contact the instructor. In addition, you need to be registered with Disability Support Services Office in the Allen Center. The policy of Rice University regarding disabilities are observed: see http://ga.rice.edu/.

Other policies

All other policies of Rice University are observed: see http://ga.rice.edu/.

REFERENCES

Cowell, R., Dawid, P., Lauritzen, S., and Spiegelhalter, D. (2003), *Probabilistic Networks and Expert Systems: Exact Computational Methods for Bayesian Networks*, New York: Springer.

Koller, D., and Friedman, N. (2009), *Probabilistic Graphical Models. Principles and Techniques*, Cambridge, Massachusetts: MIT Press.

Koski, T., and Noble, J. M. (2009), *Bayesian Networks: An Introduction*, Chichester: Wiley.

Lauritzen, S. (1996), *Graphical Models*, Oxford, UK: Oxford University Press.

Wainwright, M. J., and Jordan, M. I. (2008), "Graphical models, exponential families, and variational inference," *Foundations and Trends in Machine Learning*, 1, 1–305.